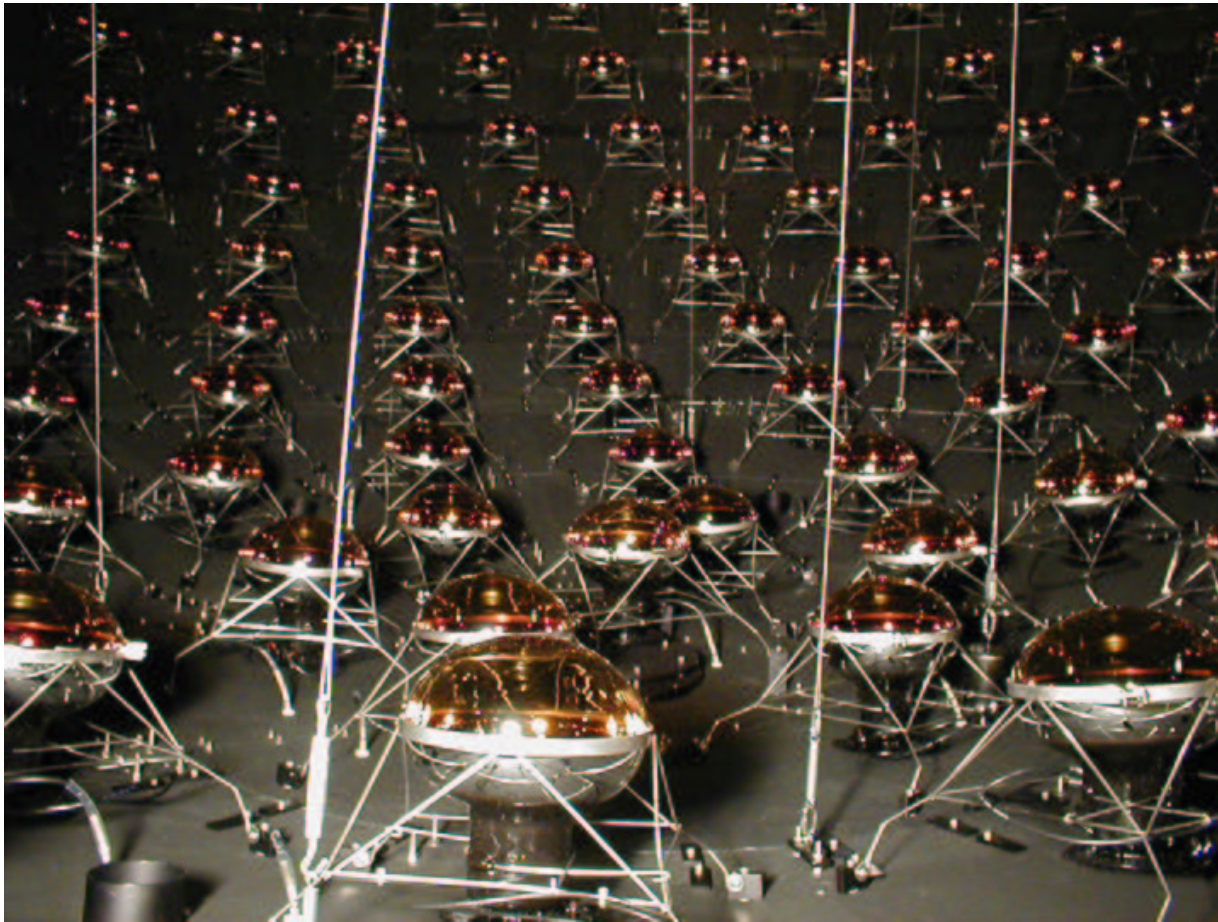


MiniBooNE Status

Steve Brice
Fermilab



Overview

Beam

- Primary Beam
- Secondary Beam

Detector

- Calibration
- Triggering
- Neutrinos

Summary

The Collaboration

The BooNE Collaboration

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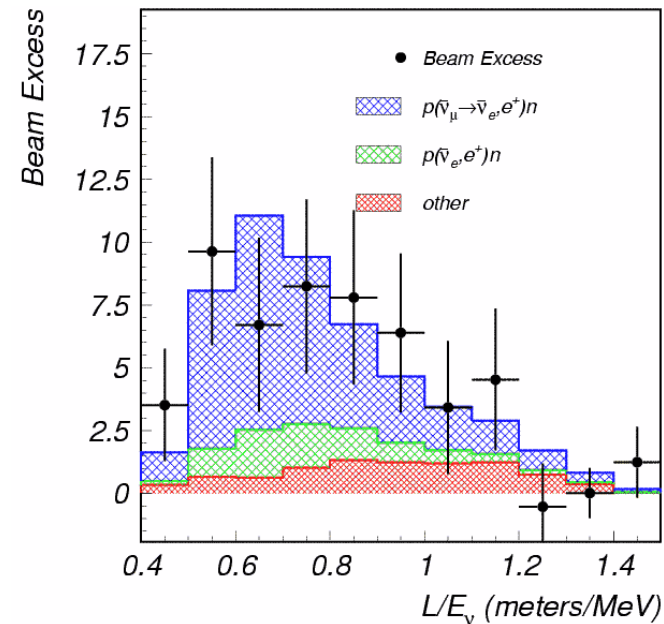
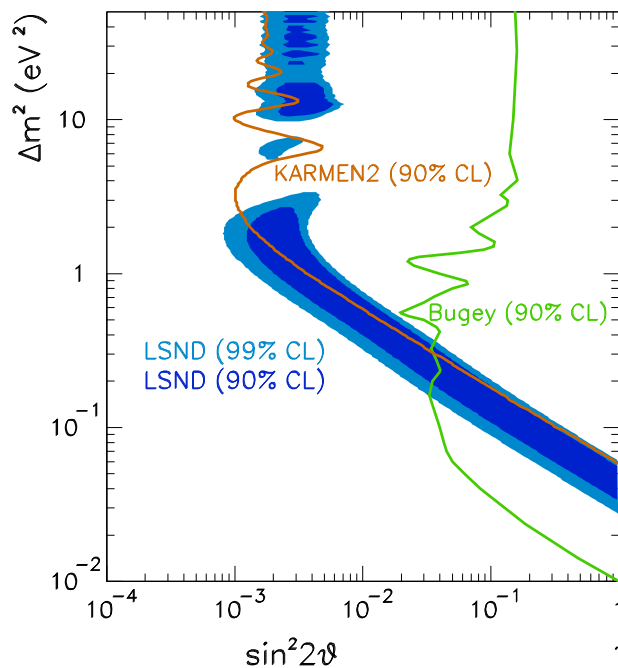
Small experiment

- ~60 scientists
- 13 institutions



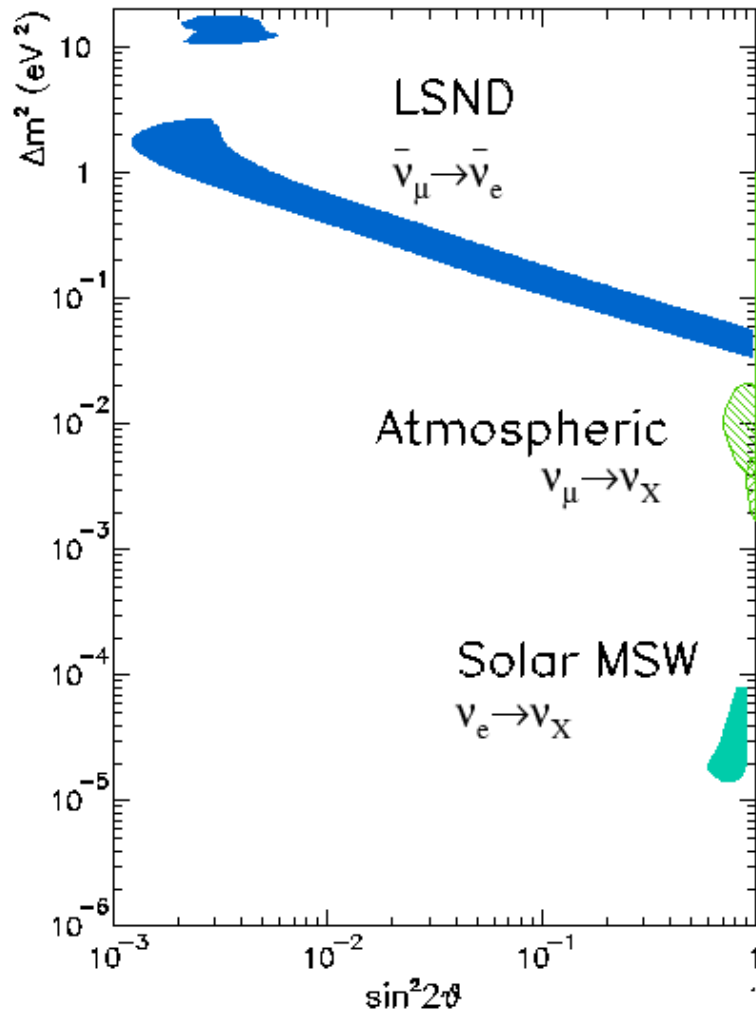
Investigating LSND Result

- LSND:
 - Excess of $\bar{\nu}_e$ events in a $\bar{\nu}_m$ beam
 - $87.9 \pm 22.4 \pm 6.0$ over background
 - 4s evidence for n oscillation



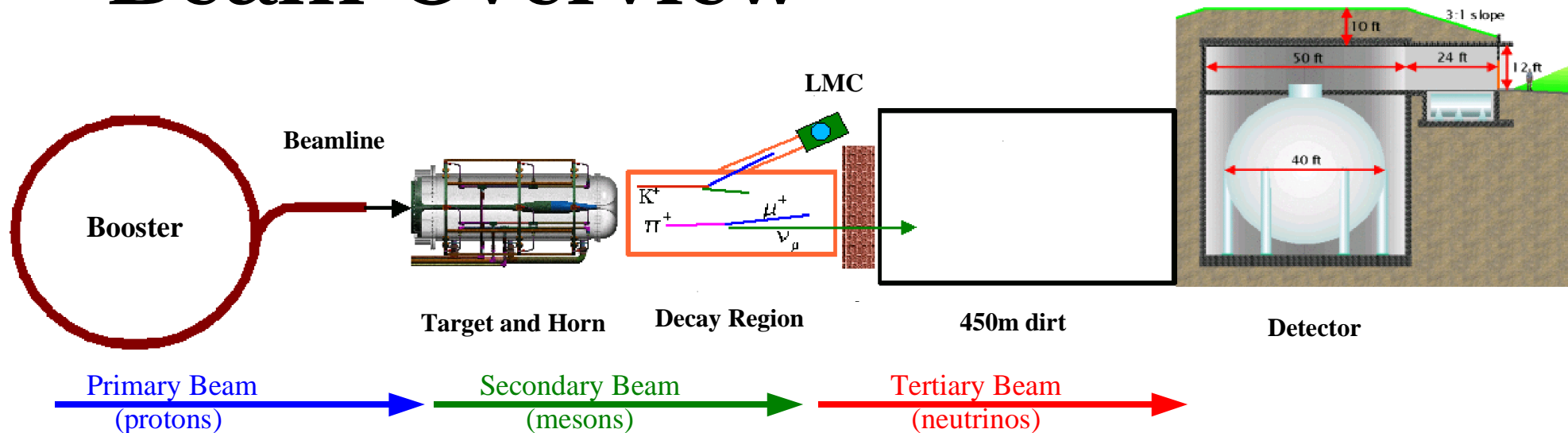
- To Check LSND you want
 - Experiment with
 - different systematics
 - higher statistics
 - similar L/E
- ➔ MiniBooNE

Why is the LSND Result Interesting?



- LEP measurement of Z width says...
 - 3 light, active neutrinos
- Solar, atmospheric, and LSND neutrino measurements indicate...
 - 3 different Δm^2 scales
- Cannot get 3 Δm^2 scales from 3 masses
- Some possible ways out...
 - one or more results not due to oscillations
 - add sterile neutrino(s)
 - violate CPT

Beam Overview



Primary Beam

- 8 GeV protons from Booster
- Into MiniBooNE beamline

Secondary Beam

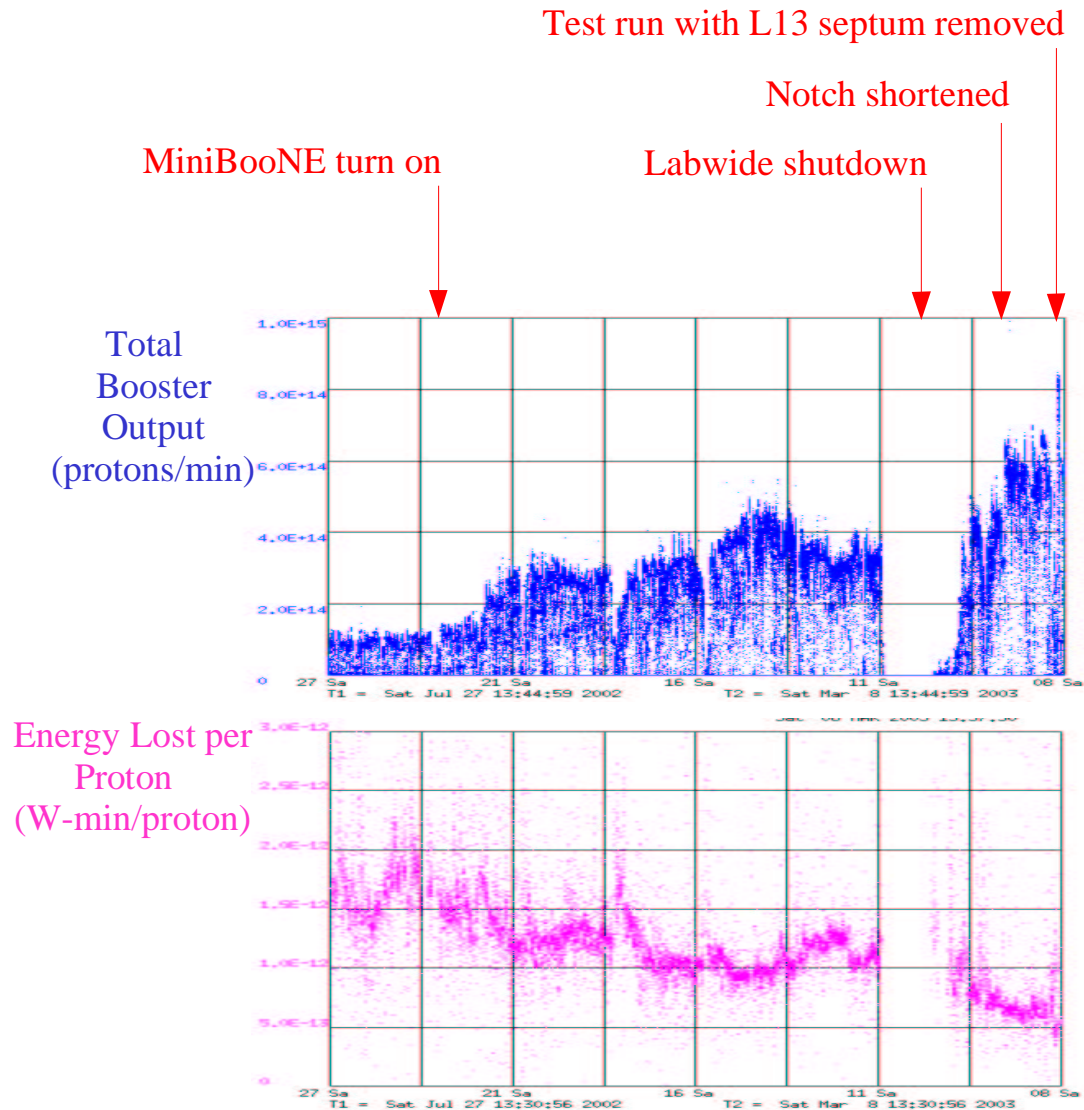
- Mesons from protons striking Be target
- Focused by magnetic horn and monitored by LMC

Tertiary Beam

- Neutrinos from meson decay in 50m pipe
- Pass through 450m dirt (and oscillate?) to reach detector

Booster Performance

- Booster has never worked this hard
- Steady increase in rate of delivered protons via ...
 - Careful tuning
 - Optimising rep rate and charge per pulse
- On 6 March set all time Booster record ...
 - 5.7×10^{16} protons/hour
- Currently average ...
 - $3\text{--}4 \times 10^{16}$ protons/hour
- Need ~2-3 times higher rate to get to 10^{21} protons on target



Future Booster Improvements

- **Booster studies**
 - Recent physics staff increases and dramatic increase in involvement of Beam Physics Department
 - Already paying off (e.g. septum dogleg beam losses)
- **Collimation system**
 - Design almost complete
 - Installation ~ June 1
- **Large Aperture RF Cavities**
 - Increase aperture from 2¼” to 5”
 - Powered prototype tested
 - 2 vacuum prototypes being built for summer shutdown
 - Propose to build whole new system (18 cavities + power supplies)

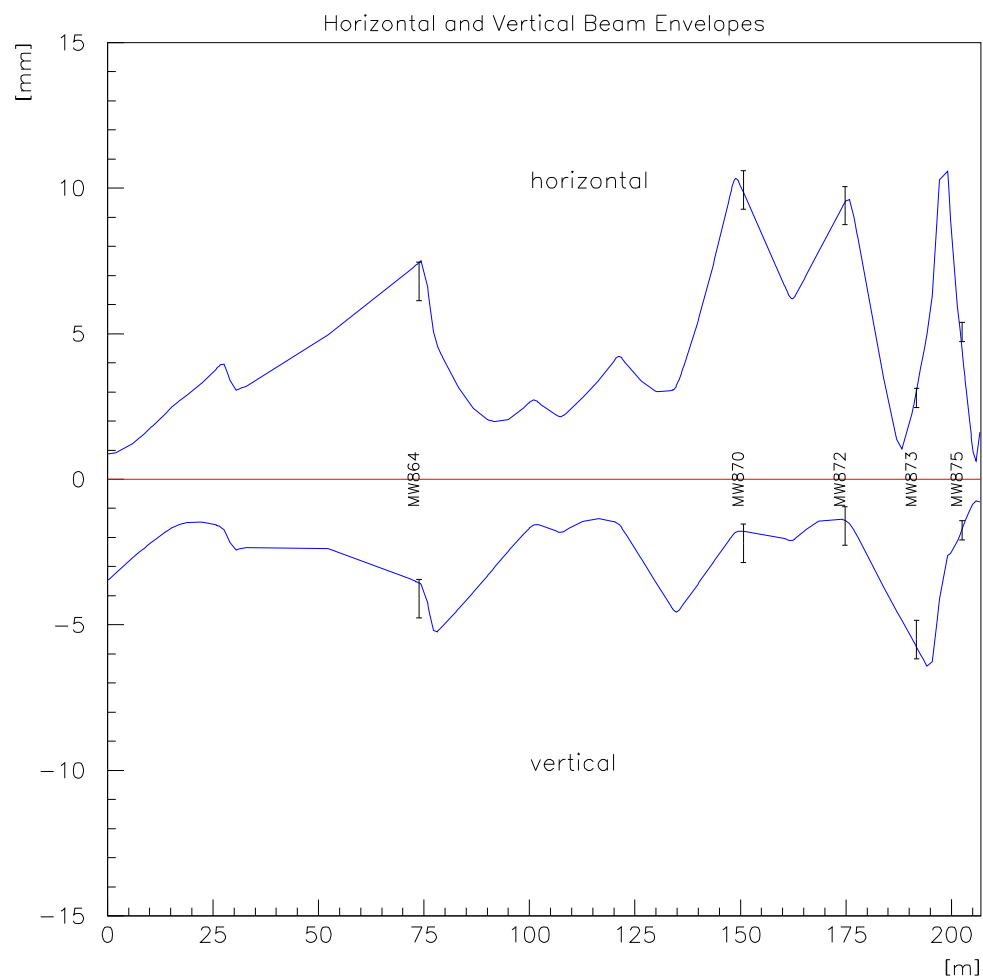




MiniBooNE Beamline

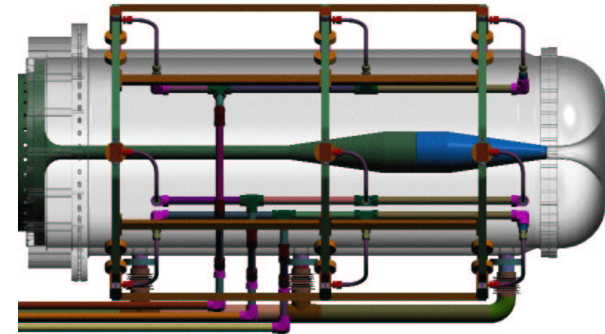
- Beamline works well
- Beamline modelling works well

- Phase I beam (intermediate dump)
 - April 29 2002
- Phase II beam (multiwire instead of target)
 - June 26 2002
- Phase III beam (final configuration)
 - August 24 2002



Horn and Target Performance

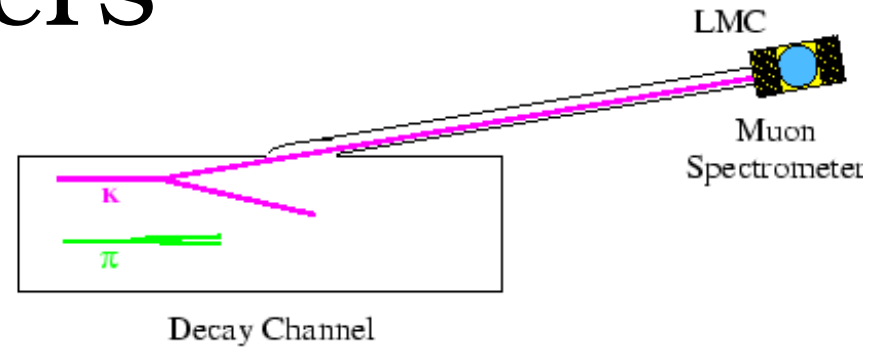
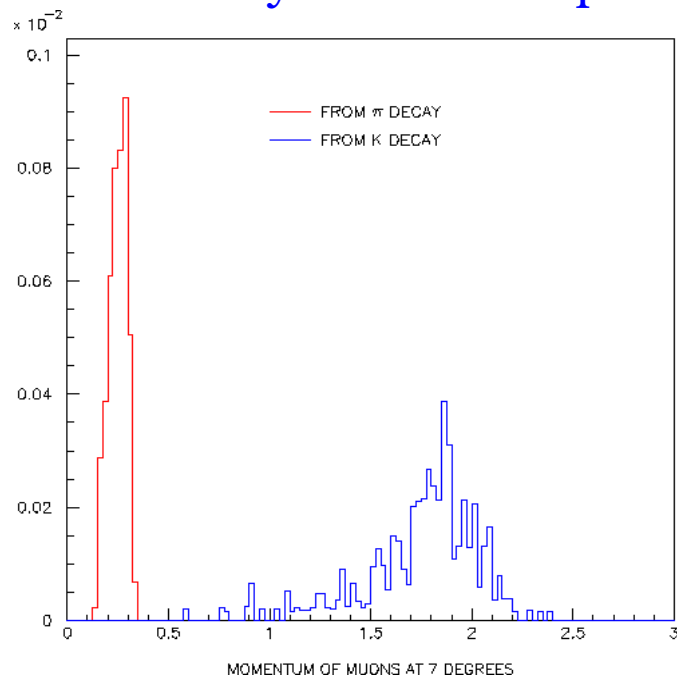
- Protons impinge on 71cm long, air cooled Beryllium target
- Horn focusing of secondary beam increases n flux by factor of ~ 7
- 170 kA pulses, 143ms long at ~ 5 Hz
- 200 million pulse design lifetime



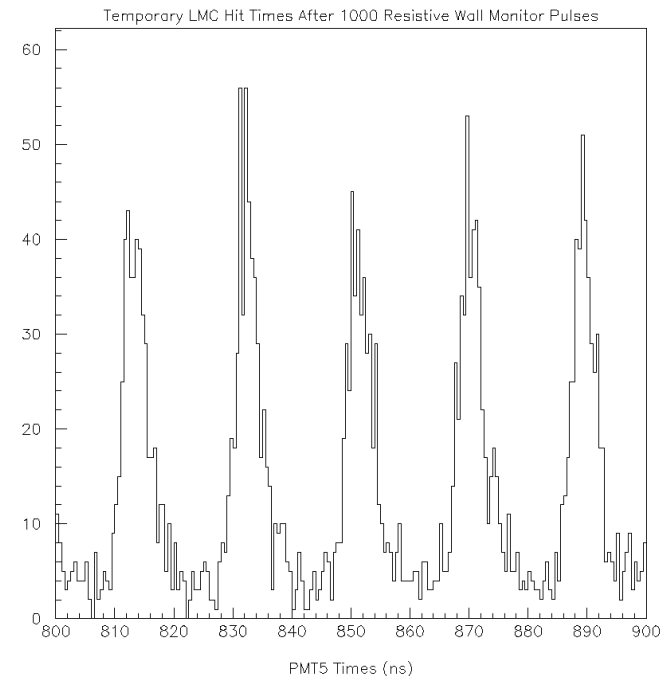
- Horn stress tested with 10 million pulses in Nov-Dec 2001
- Installation completed June 2002
- Has performed flawlessly with ~ 11 million pulses in situ to date

Little Muon Counters

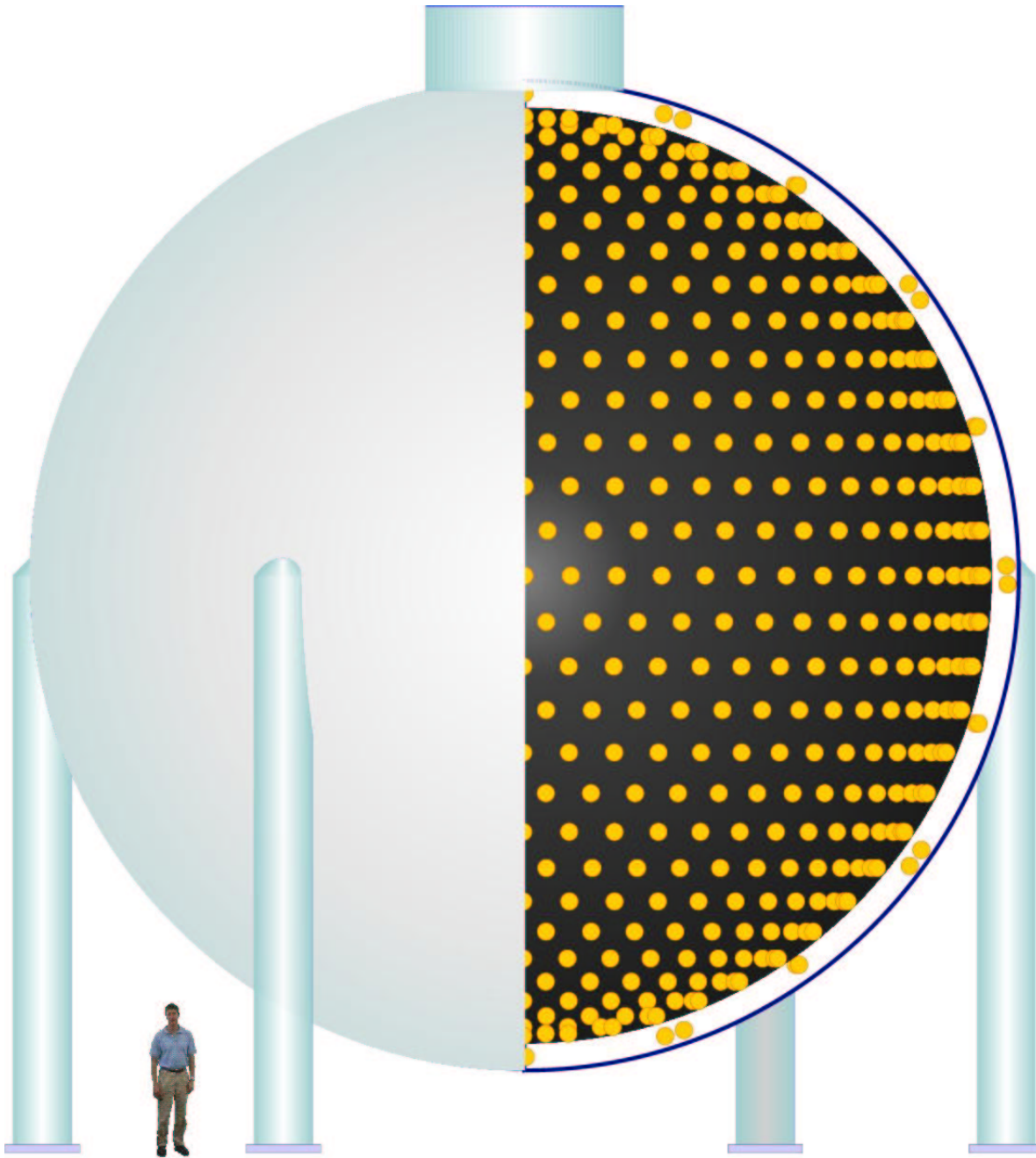
- n_e s from K decay are a major background
- K decays produce wider angle muons than p decays
- LMC muon spectrometer
- 7 degrees off axis
- Scintillating fibre tracker
- Currently scintillator paddles



- LMC triggered off beam-on-target signal
- Can see 53MHz beam microstructure



Detector Overview

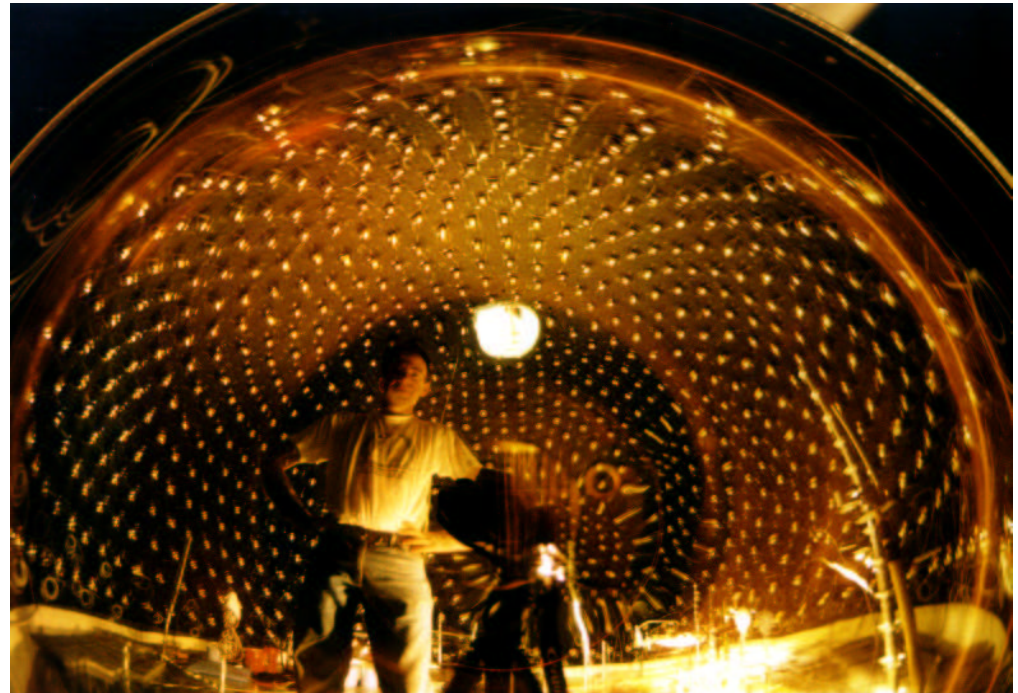


- 12m diameter sphere
- Filled with 950,000 litres of pure mineral oil
- Light tight inner region with 1280 8" PMTs (10% coverage)
- 240 PMTs in outer veto region
- **Neutrino Interactions in oil produce**
 - Prompt Čerenkov light
 - Delayed scintillation light

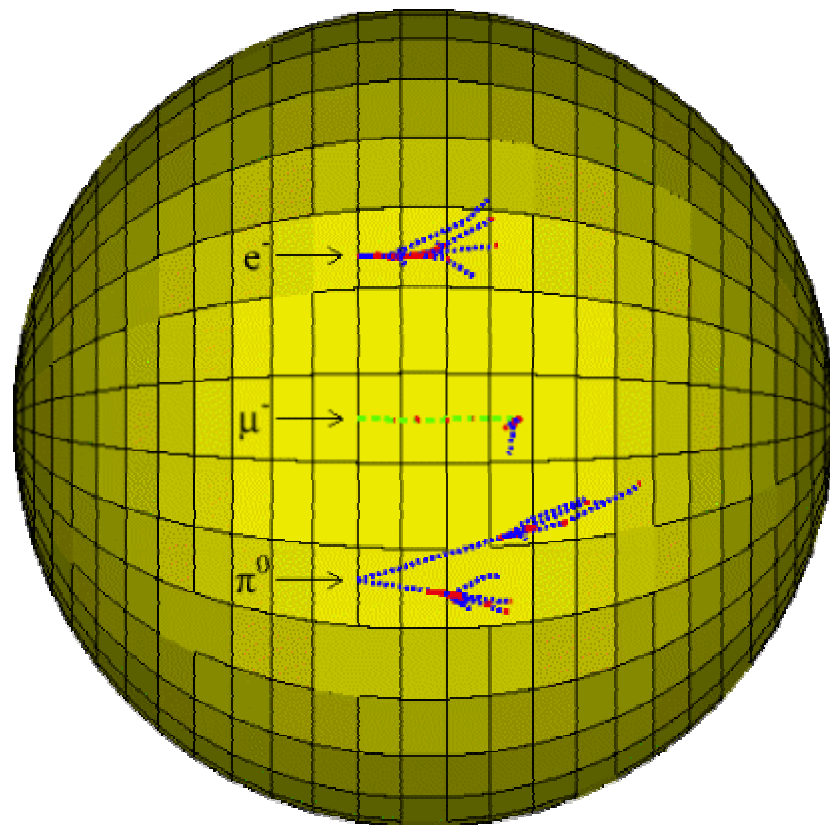
Detector Construction



- Fully Complete April 2002
- Several months of shakedown and calibration prior to first beam



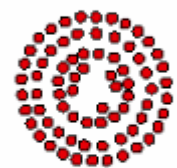
MiniBooNE Particle ID



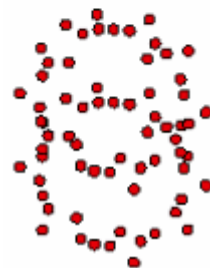
- Identify electrons (and thus candidate n_e events) from characteristic hit topology



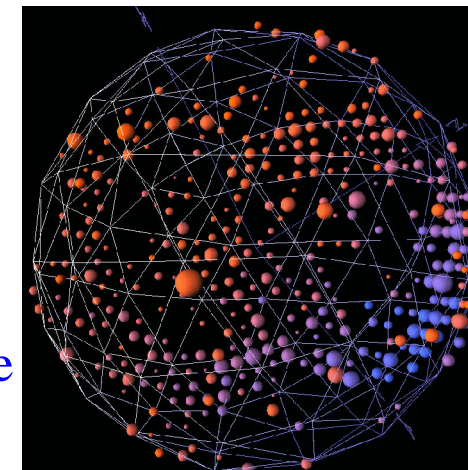
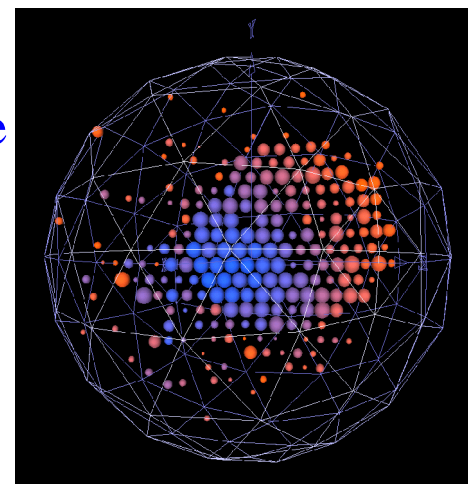
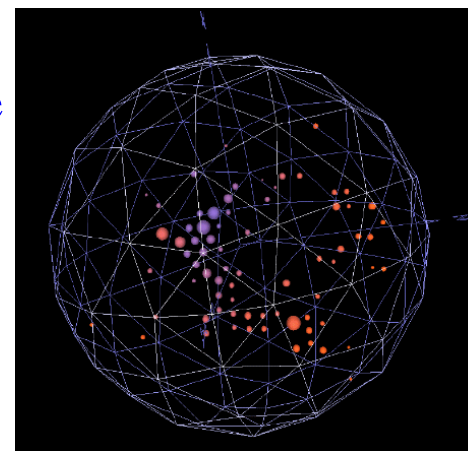
Michel e
candidate



Beam μ
candidate



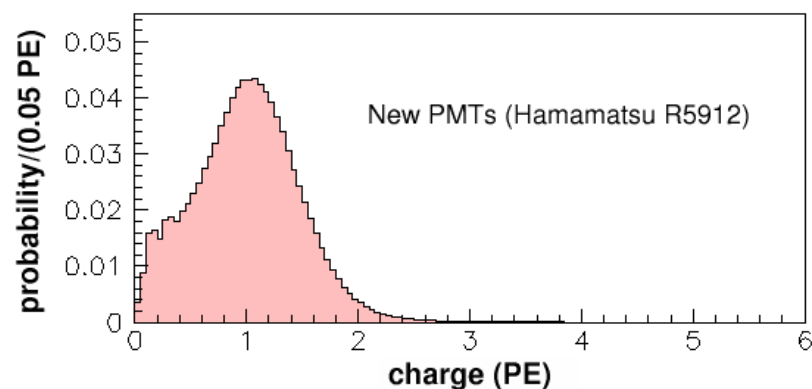
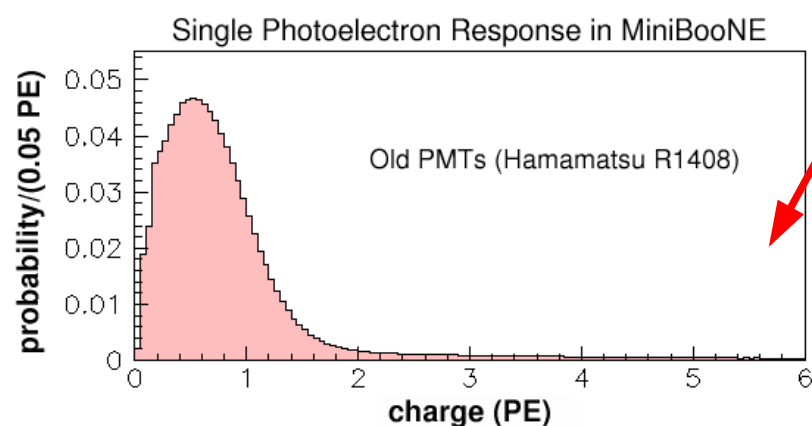
Beam π^0
candidate



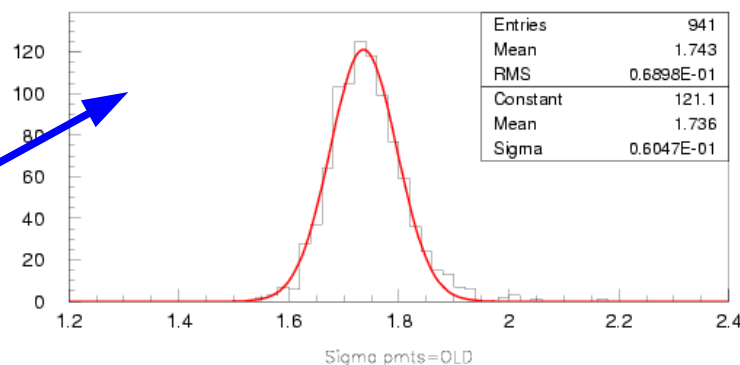
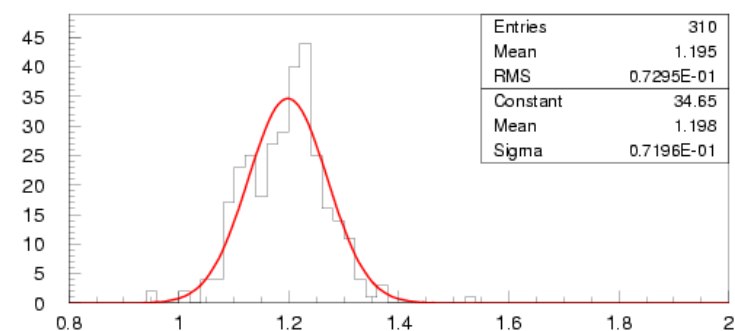
Laser Flask System

- 4 Flasks distributed about the tank

- Measure tube charge response (needed for energy measurement)



- Measure tube timing response (needed for event reconstruction)

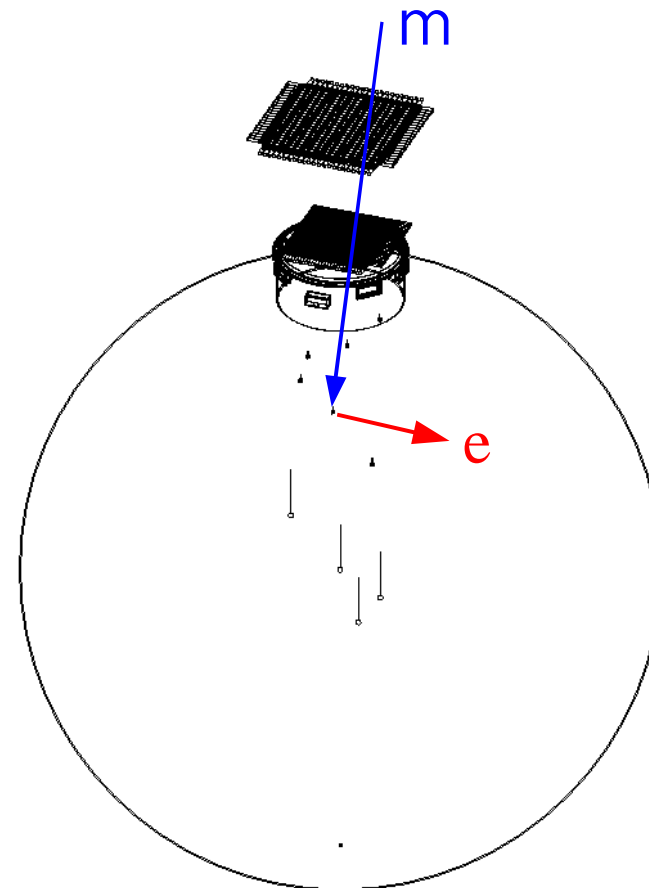


Muon Tracker and Cubes

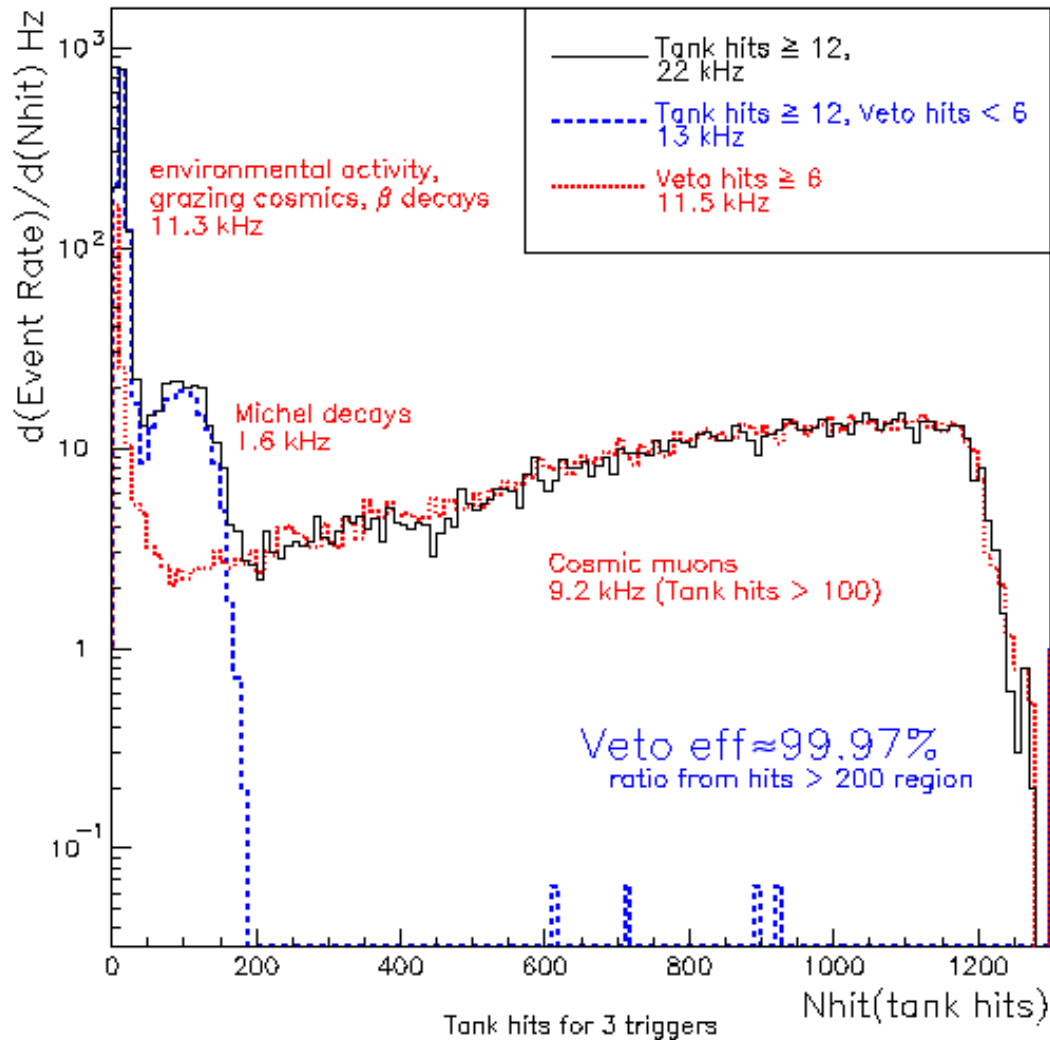


- Scintillator cubes
- 7 throughout the tank
- Provides muons and Michel electrons of known position

- Muon tracker system
- Provides muons of known direction in the tank
- Key to understanding energy and reconstruction



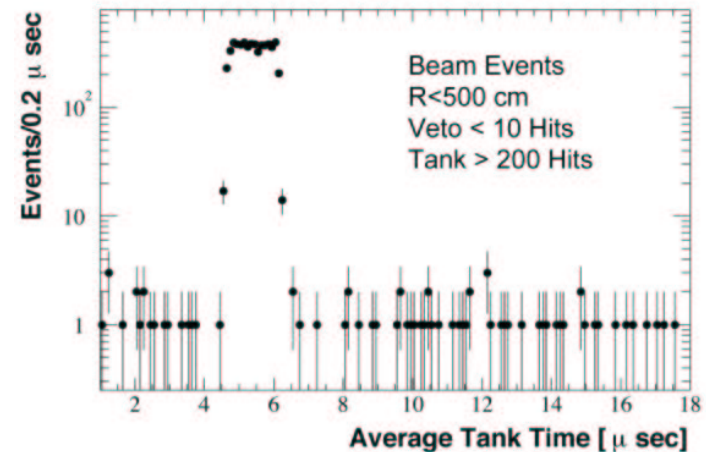
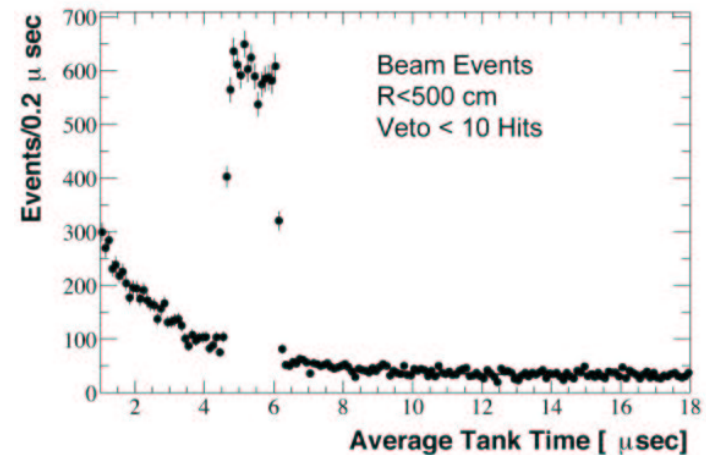
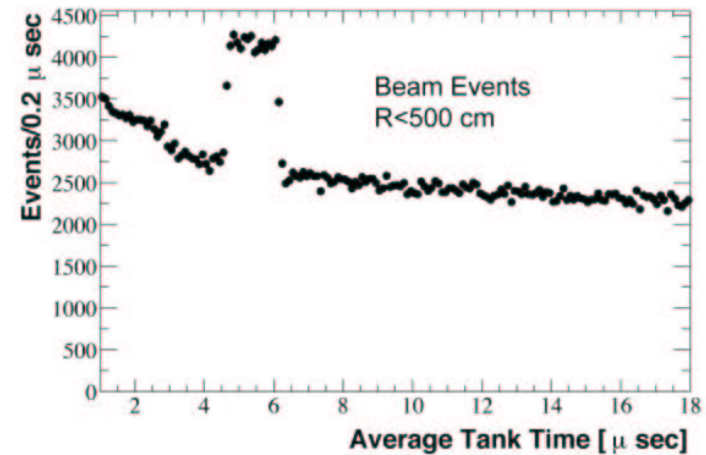
DAQ and Triggering



- Variety of triggers
 - Laser
 - Tracker and cube
 - Strobe
 - Beam
 - Tank activity
- Understand detector response down to a few MeV

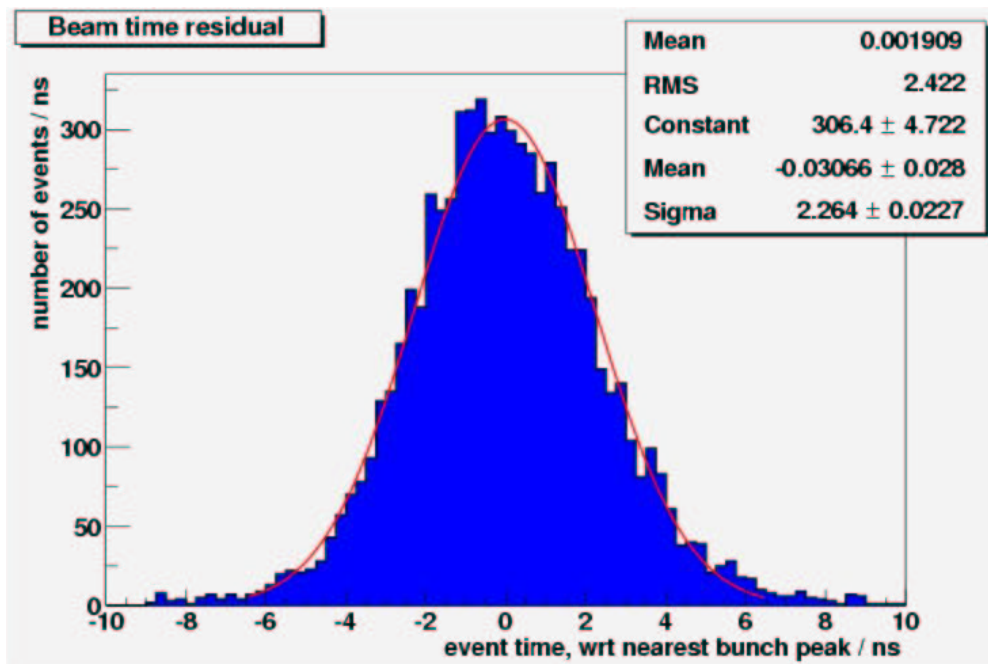
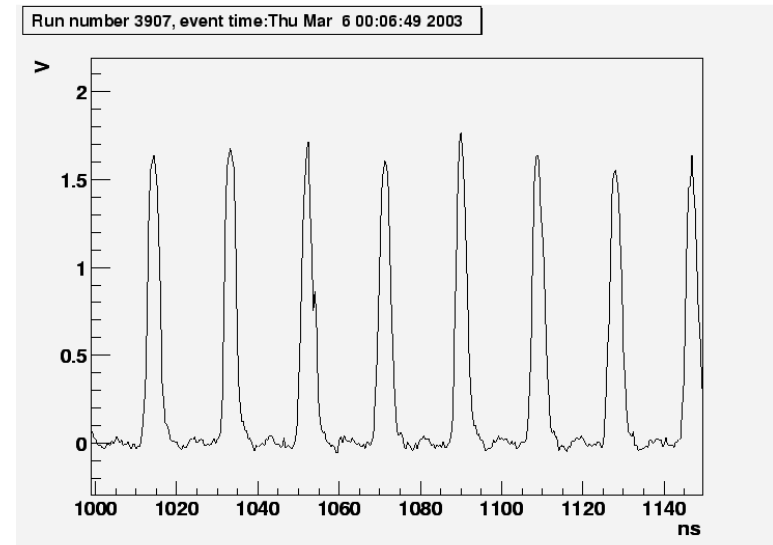
Coarse Beam Event Timing

- DAQ triggered on beam from Booster
- Detector read out for 19.2 μs
- Neutrino pulse through detector lasts 1.6 μs
- With a few very simple cuts non-neutrino/neutrino rate is $\sim 10^{-3}$



Fine Beam Event Timing

- A resistive wall monitor measures the beam time profile just before the target
- Discriminated signal sent to DAQ for fine timing



With ...

- Fitted event position
- Fitted event time
- RWM timing pulse

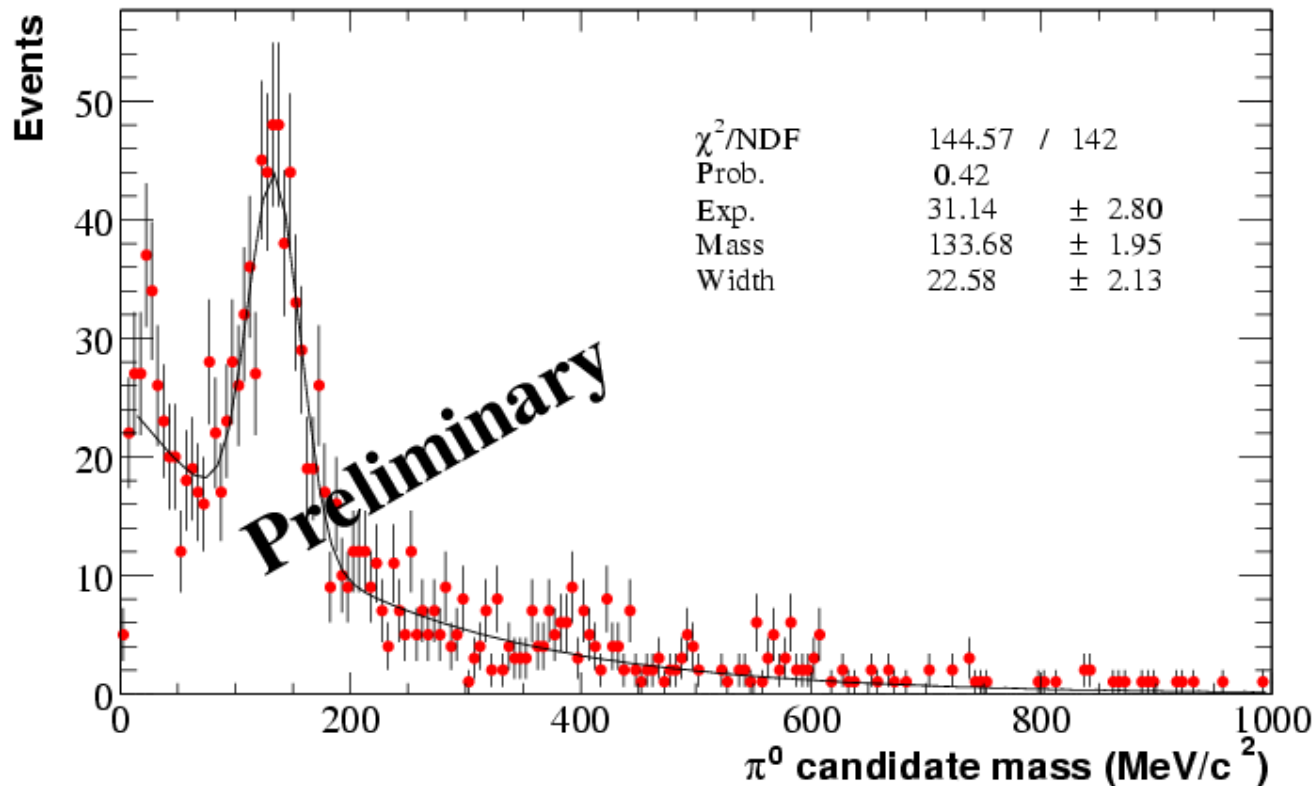
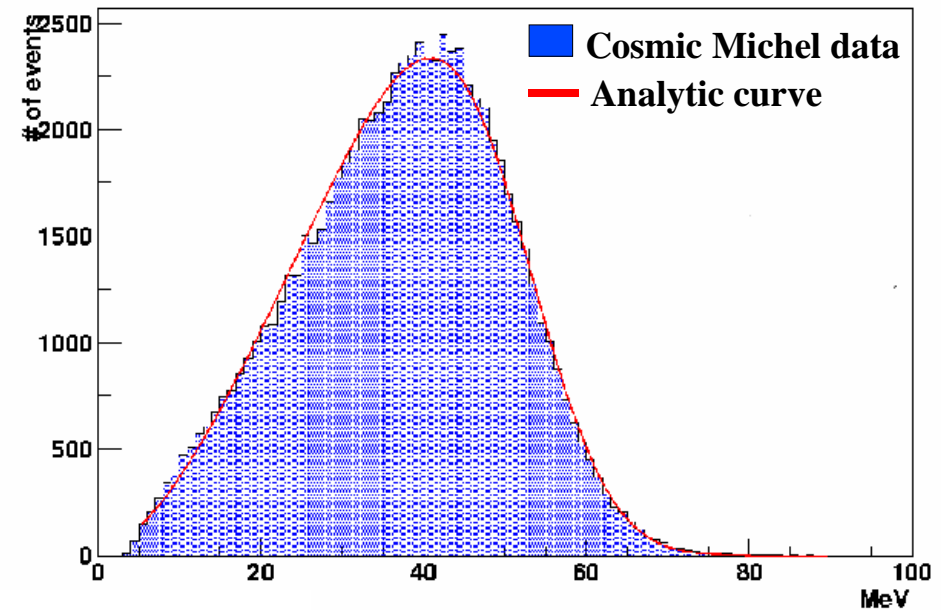
we measure the booster
bunch timing....

in neutrinos!

Energy Response

Cosmic Michel Decays

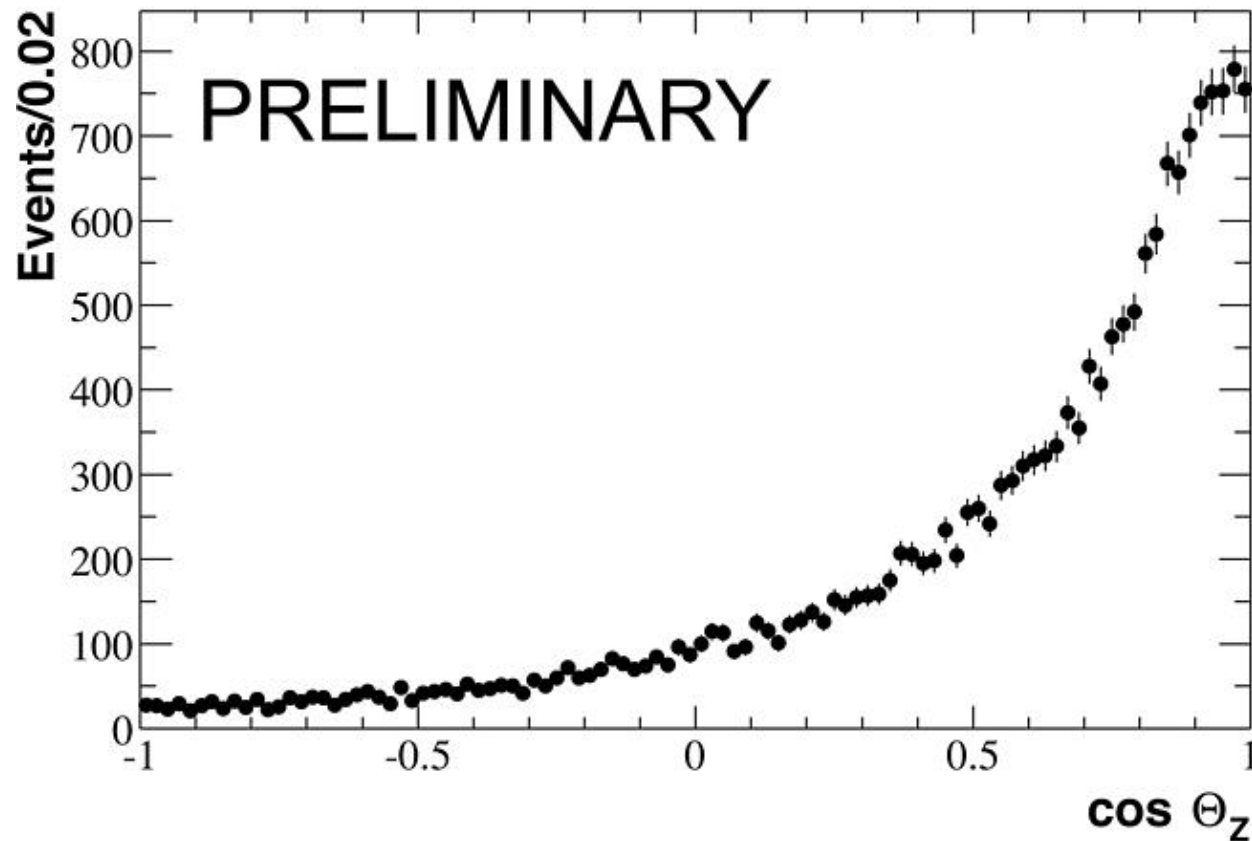
- Used to set energy scale



p^0 mass reconstruction

- In Beam Time window
- Tank hits > 200
- Veto hits < 6
- Both rings > ~60MeV

Reconstruction: Charged Lepton Direction



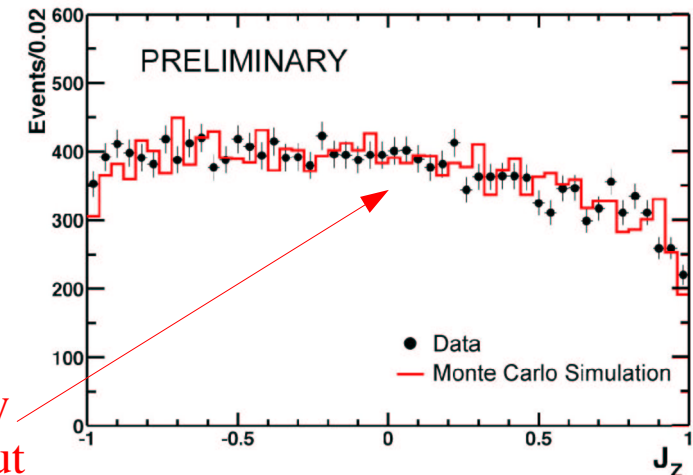
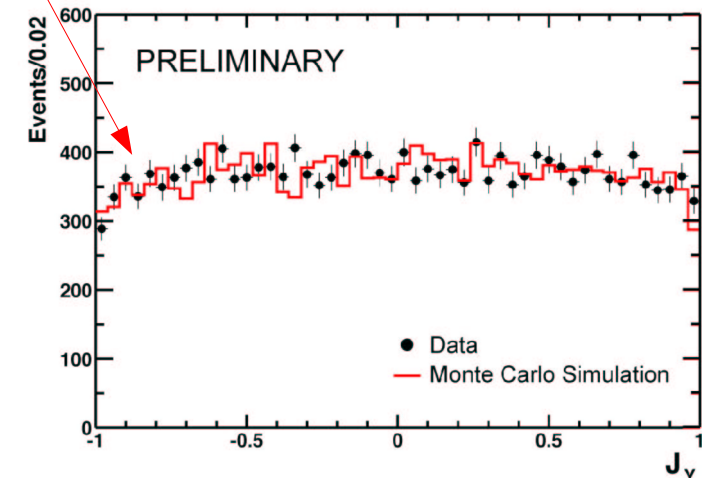
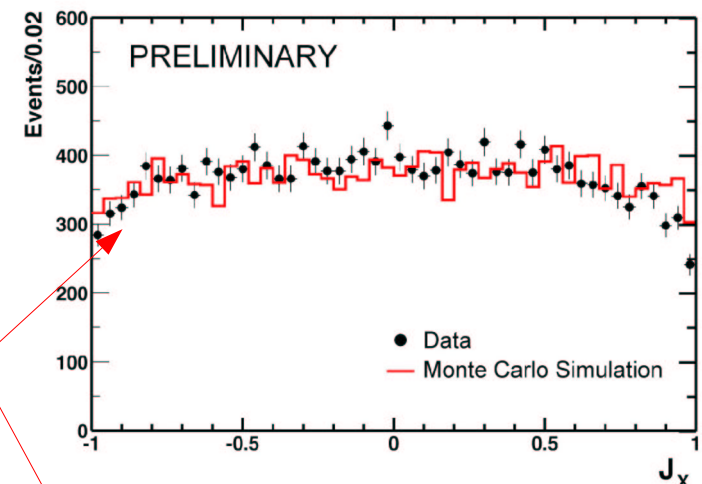
Fitted direction with
respect to beam

- Tank hits > 200
- Veto hits < 6
- Fit radius < 500cm

Reconstruction: Event Position

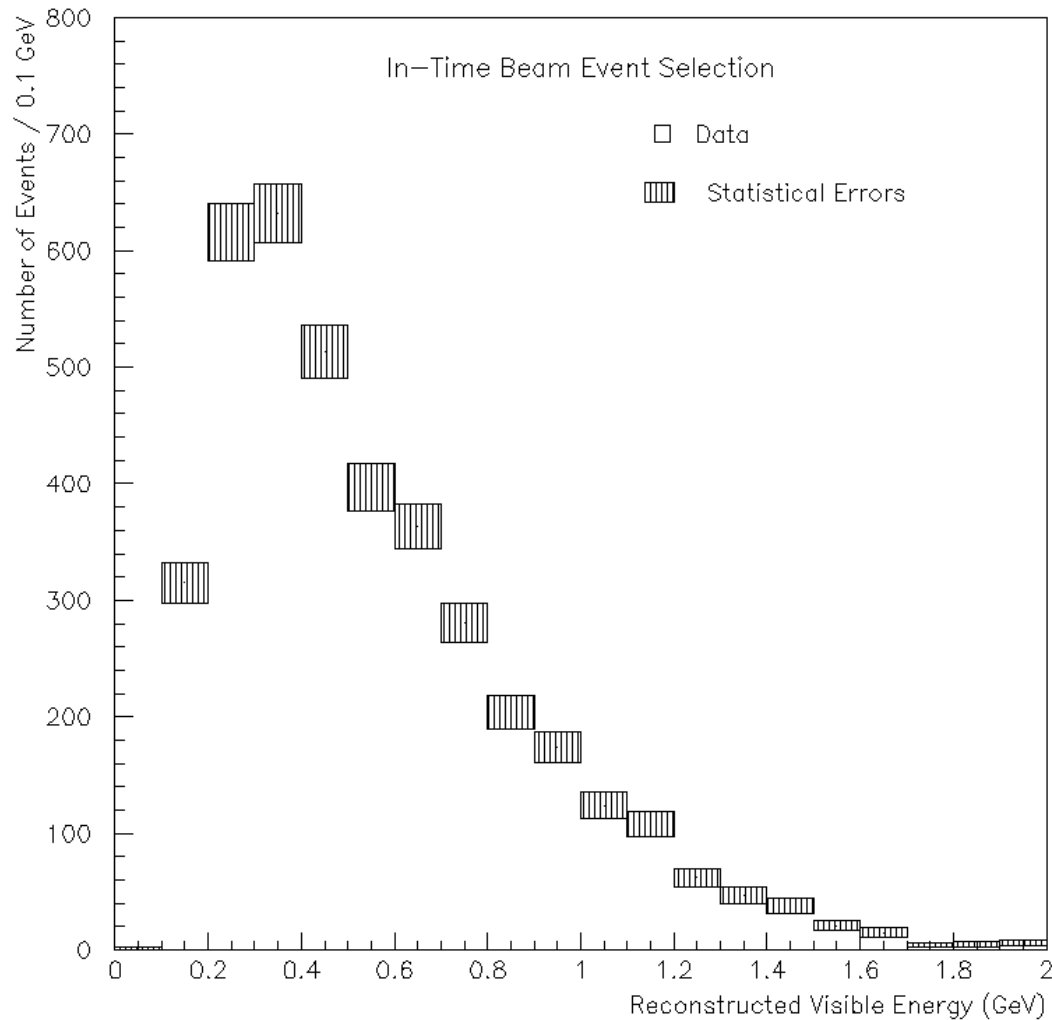
- Fitted position of the centre of the event track
- Cuts:-
 - Tank hits > 200
 - Veto hits < 6
 - Fit radius $< 500\text{cm}$
- Cartesian coordinates scaled to give equal volume slices in a sphere

Rolloff at edges
from veto cut



Asymmetry from anisotropy
of event directions + veto cut

Reconstruction: Energy



Preliminary Visible Energy

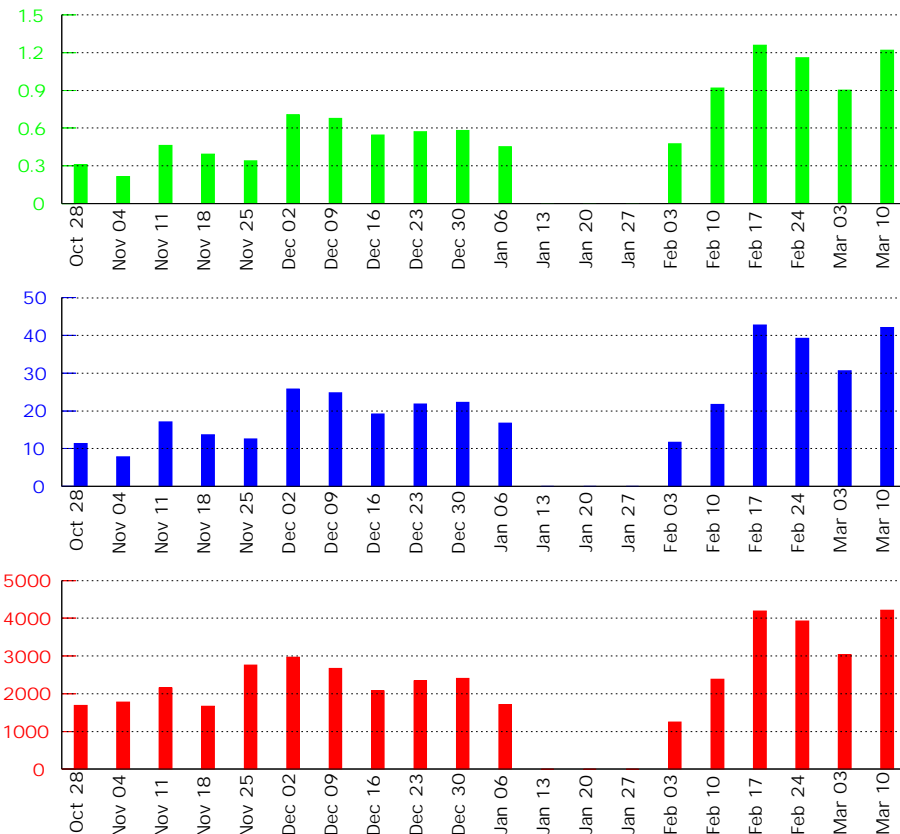
CUTS:-

- In beam time window
- Tank hits > 200
- Veto hits < 6
- Fitted radius < 450

Flux falls in range of MC predictions

HARP and E910 analyses will tighten prediction

Summary



Number of Horn Pulses

To Date: 11.18 million
Best Week: 1.25 million
Last Week: 1.22 million

Number of Protons on Target

To Date: 381.4 E17
Best Week: 42.8 E17
Last Week: 42.1 E17

Number of Neutrino Events

To Date: 43234
Best Week: 4213
Last Week: 4213

- All systems working well
- We're at 4% of 10^{21} protons on target
- Just need to continue improvement in beam.